Safety and Health at Work 6 (2015) 329–337

Contents lists available at ScienceDirect

Safety and Health at Work

journal homepage: www.e-shaw.org

Original Article

Work–Family Conflict, Task Interruptions, and Influence at Work Predict Musculoskeletal Pain in Operating Room Nurses

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ARTICLE INFO

Article history:
Received 6 October 2014
Received in revised form
18 February 2015
Accepted 31 July 2015
Available online 18 August 2015

Keywords:
musculoskeletal disorders
nurses
resources
work stressors

ABSTRACT

Background: The aim of this study is to examine the prevalence of musculoskeletal complaints in Swiss operating room (OR) nurses, and to investigate how work–family conflict, work interruptions, and influence at work are related to lumbar and cervical back pain.
Methods: Participants in this correlational questionnaire study included 116 OR nurses from eight different hospitals in Switzerland.
Results: We found that 66% of the OR staff suffered from musculoskeletal problems. The most prevalent musculoskeletal complaints were lumbar (52.7%) and cervical pain (38.4%). Furthermore, 20.5% reported pain in the mid spine region, 20.5% in the knees and legs, and 9.8% in the hands and feet. Multiple linear regression analyses showed that work–family conflict ($p < 0.05$) and interruptions ($p < 0.05$) significantly predicted lumbar and cervical pain in OR nurses, while influence at work ($p < 0.05$) only predicted lumbar pain.
Conclusion: These results suggest that reducing the work–family conflict and interruptions at work, as well as offering opportunities to influence one's workplace, help to promote OR nurses' health.

1. Introduction

In Switzerland, musculoskeletal disorders (MSD) are responsible for causing economic costs of 3.3 billion and 0.97 billion Swiss francs, due to loss of productivity and absence from work, respectively [1]. Back pain alone, for example, entails costs of between 6 billion and 14 billion Swiss francs, which amounts to 1.3–3.2% of the gross domestic product in Switzerland (Schweizerischer Nationalfonds SNF 2009). More specifically, low back pain is responsible for about 3.2 billion Swiss francs in direct costs, and its direct medical costs make up 6.1% of the total healthcare expenditure in Switzerland [2]. Intangible costs should not be underestimated either, even if they are extremely difficult to estimate. They include psychosocial burdens, such as job stress, suffering, family stress, and economic stress, which all result in a reduced quality of life [3]. Taking a closer look at the general prevalence of MSD, Elfering and Mannion [3] estimated that the yearly prevalence of back pain ranges from 25% to 45% in Europe, and from 15% to 20% in the United States, whereas the prevalence of low back pain in Switzerland increased from 13% in 1984 to 21% in 1998 [4].

Not every profession seems to be equally affected by MSD. According to the Bureau of Labour Statistics, nurses are at an especially high risk of developing musculoskeletal problems [5]. Overall, the annual occurrence of MSD for registered nurses ranged from 30% to 60%, depending on the specific body region involved [6]. An even higher prevalence is found for operating room (OR) nurses. Studies dealing with the specific occupational group of OR nurses found that in different studies, the majority of the OR nurses reported shoulder and lower back pain in the last 12 months, with frequencies ranging from 58% to 90% [7–10]. In Choobineh et al [8], lower back symptoms were found to be the most prevalent musculoskeletal problem in OR nurses.

It is suggested that repetitive movements and remaining in a static position [11,12] for hours when holding and reaching the

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2093-7911/$ – see front matter
http://dx.doi.org/10.1016/j.shaw.2015.07.011

surgical instruments are reasons for this high occurrence. Indeed, research shows that the typical working life of nursing staff is characterized by unusual motions and postures [13,14], and that being exposed to physical risks like repetitive motions, excessive work load, bad posture, vibrations, motions, lifting and bearing heavy things increased the risk of developing musculoskeletal problems in general [4]. The mentioned physical risks are also found to be associated with back pain in particular [15].

The psychosocial aspects of work that contribute to MSD in OR nurses have rarely been investigated so far. Such factors found in the literature include: shift work, conflicting demands, time pressure, and static stress [8,11,12]. This means that the more affected OR nurses were by these factors, the higher/more often their reported musculoskeletal complaints were.

To the knowledge of the authors, important and frequent work stressors, including work–family conflict and interruptions at work, have not been investigated yet in OR nurses, although a recent meta-analysis underlined the impact of the work–family conflict and privacy-work conflict on wellbeing and health [16]. Grzywacz et al [17] found that work–family conflict was a previously neglected, but salient, problem among nurses, as 50% reported chronic work interference with family, meaning that conflicts occur at least once a week because of it. Even though the work–family conflict seems to affect one's health, it has rarely been studied in association with pain [18]. According to the study by Hämmig et al [19], employees who were most frequently exposed to the work-to-life conflict were also most at risk for developing low back pain and neck/shoulder pain. Furthermore, having a variable work schedule was found to be an important predictor of work-to-life conflict [19]. Variable work schedules are common factors in the typical work life of OR nurses [8,9]. Thus, the current study assumes that the work–family conflict might be an important work stressor for OR nurses and will therefore predict significantly and positively lumbar and cervical musculoskeletal pain (Hypothesis 1).

Another common stressor in healthcare is interruption at work [20]. According to Elfering et al [21], interruptions at work may trigger failure in action regulation. Thus, interruptions during an OR nurse's work represent a threat to surgery outcomes and patient safety, and are stressful for OR nurses. Stress, in turn, is related to MSD [3,22–25] via a variety of mental (e.g., pain-related fear or individual coping styles) and bodily mechanisms (e.g., dysfunction of the hypothalamic–pituitary–adrenal axis or stress-induced changes in the temporal lobe) [25]. Therefore, the current study suggests that interruptions at work, as a work stressor, may be significantly and positively associated with lumbar and cervical musculoskeletal pain (Hypothesis 2).

In addition to work stressors promoting MSD, the authors of the current study were also interested in the nurse's influence at work as a psychosocial factor that can prevent someone from developing musculoskeletal symptoms or disorders. Eatough et al [26] found that having influence over how to perform one's job and whether or not one had the opportunity to make decisions relevant to one's job reduced the perceived strain, which in turn decreased pain in the lower back, shoulders, wrists, and hands. The review of publications on psychosocial factors at work and musculoskeletal disease from Bongers et al [27] concluded that having low influence on one's job was connected with more MSD, and alternatively, experiencing a high level of job control served as a buffer for MSD. These findings are widely shared because lack of control at work is often associated with pain in the lower back, shoulders, neck, knees, and forearms [28–31], as well as with shrinkage of spinal discs throughout the working day [32]. In nurses, lack of influence was determined to be a risk factor for the development of musculoskeletal complaints, and especially for the chronicity of musculoskeletal pain [33]. The influence to decide on when and in what sequence to do specific tasks was shown to be a resource factor in young nurses, as it was negatively associated with low back pain and catecholamines during work [34]. Bos et al [7] state that OR nurses perceive less job influence as compared with registered nurses. Therefore, the authors assume that influence at one's work significantly and negatively predicts the extent of lumbar and cervical musculoskeletal complaints in OR nurses (Hypothesis 3).

In summary, OR nurses have not been investigated very often in previous studies and the determined number of factors associated with musculoskeletal pain in this cohort is still low. However, evidence is mounting that OR nurses are more affected by musculoskeletal pain (with a 1 year prevalence ranging from 58% to 90%) than is the general population (with yearly occurrence of 25–45%) or nonspecialized nurses (annually 30–60%) [7]. Lumbar back pain (lower back, loins, hips, small of the back, and pelvis) and cervical back pain (pain in the neck and shoulders) seem to occur most frequently [8,9]. The aim of the current study is to investigate the distribution of MSD in general, and especially of lumbar and cervical back pain in OR nurses in Switzerland, because no corresponding Swiss studies can be found in the current body of literature. Another goal is to look more closely at the influence of factors, such as work–family conflict, interruptions, and influence at work, on predicting lumbar and cervical pain.

2. Materials and methods

2.1. Sample

The study population consisted of 116 employees of eight different hospitals from around the Canton of Bern in Switzerland. The group of eight hospitals was composed of a large university hospital, three other public hospitals, two smaller and more regional semi-private hospitals, and two smaller and more regional private hospitals. This common mixture of different types of hospitals is therefore representative within Switzerland. A total of 312 questionnaires were distributed, and 133 were returned. This resulted in a response rate of 42.6%.

All participants gave their informed consent and the study was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki), and was approved by the Ethics Committee of the Canton of Bern, Switzerland (KEK No. Z001/13). Seventeen questionnaires had to be excluded due to missing data, so the final sample included 116 employees. The 97 women and 19 men were aged between 21 and 63 years old [mean = 39.9, standard deviation (SD) = 11.9], and each member of the sample group worked amongst others in the OR, with most of them assisting the surgeons by holding and reaching for the surgical instruments or by positioning the patient during surgery. About 64% of the respondents worked between 90% or full-time (42 contracted h/wk), 25% worked part-time hours of $>$ 50% but $<$ 90%, and 11% worked $\leq$ 50%. Their job tenure averaged 15 years (SD = 10.6). The authors have no information about the nonresponders. During data collection, the author's impression was that some of the later nonresponders might have been too busy to answer the questionnaire. Literature shows that nurses are often under time pressure or work overtime [8,11,35]. If time pressure and work overload had triggered nonresponse, it could most likely be that those would also report more work–family conflicts than the responders. Therefore, our results presumably underestimate the extent of work–family conflicts in OR nurses.

2.2. Study setting

After contacting the managers of each team from the eight different hospitals represented in our study, we presented our

study to the OR nurses in a team meeting and invited them to participate in a survey about the prevalence of musculoskeletal pain. Explanations about how to fill out the questionnaires were also given. The participants received a postage-paid envelope with written information about the aim and interest of the study, as well as the guarantee of confidentiality. The OR nurses were told that they would also have to answer some demographic questions and questions about their work situation, so that a global impression about their profession can be gained. The authors explicitly did not inform OR nurses about the intention to investigate if certain psychosocial working variables (work–family conflict, work interruptions, and influence at work) can have an effect on MSD to prevent bias. Also included in the study packet were a consent form and the questionnaires in the form of a booklet. The participation was voluntary and the participants who decided to fill out the questionnaire could easily send it, together with the signed consent form, back to the authors in the postage-paid envelope. A small chocolate incentive was given as a way to encourage the nurses to fill out the questionnaire and to show them our appreciation for taking their time for our survey. Two to three weeks after the visits in the hospitals, the actual response rate of their teams was reported to the managers by email and they were asked to remind those who had not participated yet to fill out the questionnaire too. After another 2–3 weeks, all of the returned booklets were counted. The team managers were contacted again by email to thank their teams for their participation and interest and to inform them about the following process of our study, including an estimation of the length of time before they would be able to learn of the results. At the end of our study, all managers were mailed a summary of the overall results, so that it could be forwarded to each person on their team.

2.3. Measures

2.3.1. Assessment of the psychosocial aspects of work

Work–family conflict was assessed using five items. These items were adapted from the Copenhagen Psychosocial Questionnaire (COPSOQ) in its shortened German version [36] that includes the original five items of Netemeyer and coworkers [37]: “The demands of my work interfere with my home and family life”, “The amount of time my job takes up makes it difficult to fulfill family responsibilities”, “Things I want to do at home do not get done because of the demands my job puts on me”, and “My job produces strain that makes it difficult to fulfill family duties.” The response format was a five-point scale ranging from 100 = “strongly agree” to 0 = “strongly disagree.” The same questionnaire was also used to assess the predicting variable influence at work by four items: “Do you have a large degree of influence concerning your work?”, “Do you have a say in choosing who you work with?”, “Can you influence the amount of work assigned to you?”, and “Do you have any influence on what you do at work?” The response format was also a five-point scale, ranging from 100 = “always” to 0 = “never/hardly ever.” The COPSOQ is a free self-administered screening instrument used for the recording of psychosocial workload and strain, and can be used for all enterprises and organizations. The assessment of the reliability, generalizability, construct validity, criterion validity, and diagnostic power of the single scales showed medium to good measuring qualities for the majority of the scales (Cronbach α mostly > 0.7), which is similar to the measuring qualities found when the original English version was used on a Danish sample. No problems were found in the objectivity, acceptance, practicability, sensitivity, and content validity of the questionnaire [37].

Interruptions at work were assessed using 15 items from the Activity and Work Analysis in Hospitals – Self-Report Version (TAA-KH-S) [38]. The TAA-KH-S is theoretically based on the action regulation theory that emphasizes interruptions as work stressors that impede goal attainment. The TAA-KH-S is a condition-related work analysis instrument, developed for the analysis of work in hospitals. The internal consistency of the total interruption scale is adequate (Cronbach $\alpha = 0.87$). Three subscales measured interruptions by persons (6 items, Cronbach $\alpha = 0.74$), interruptions by malfunctions (4 items, Cronbach $\alpha = 0.84$), and interruptions by blockings from organizational constraints, such as, for example, materials and instruments that do not arrive in time and therefore delay the work (5 items, Cronbach $\alpha = 0.79$). The response format was 1 = “never” to 5 = “very often.”

2.3.2. Assessment of musculoskeletal problems

To assess lumbar and cervical back pain as a criterion variable, the German version of the North American Spine Society (NASS) instrument was used [39]. This a self-administered questionnaire that measures the extent of back pain in clinical populations. The NASS is divided into two scales. The cervical scale is focused on pain in the region of the cervical spinal column, whereas the lumbar scale is focused on pain in the region of the lumbar spinal column. The cervical scale consists of 19 items and the lumbar scale consists of 17 items. Both scales enquire about the extent of pain and functional limitations in the corresponding body region, as well as neurogenic symptoms. This results in a total of four subscales. According to the aim of the current study, only the extent of pain and functional limitations for lumbar and cervical pain was of interest, and the neurogenic symptoms were omitted. The response format for all questions of the NASS was on a six-point scale, with parameter values depending on the questions themselves. Higher scores indicate stronger pain and greater restrictions. The NASS instrument shows a very good reliability with an internal consistency (Cronbach α) ranging from 0.89 to 0.90, and the factorial solution is robust [40].

Additionally, we evaluated data from a self-reported pain drawing used by Udén et al [41], where the OR nurses could mark their painful body regions on an illustration of a human body. This additional scale was used to get a picture of other body regions (besides lumbar and cervical regions) affected by musculoskeletal pain. For that reason, the pain drawing was evaluated by assigning each marked spot to six general body regions, defined by the authors of the current study. Participants were permitted to mark more than one region. The regions were “head area” (head and forehead), “cervical region” (neck and shoulders), “mid spine region”, “lumbar region” (lower back, loins, small of the back, hips, and pelvis), “knees/legs” and “hands/feet”. To ensure a degree of agreement among the raters, 20 of the total 116 questionnaires were randomly chosen and evaluated by two of the authors (M.N and P.K.) so that the Cohen’s kappa coefficient could be calculated [42]. A very good inter-rater reliability with $\kappa = 0.886$ was reached [43]. Subsequently, frequencies of those body zones marked as painful were calculated so that they could be considered in relation to the frequencies of lumbar and cervical back pain.

2.4. Data analysis

Statistical analyses were conducted using IBM SPSS Statistics (IBM Corp. Released 2012. IBM SPSS Statistics for Macintosh, Version 21.0. Armonk, NY: IBM Corp.). We first tested whether hospitals differed in the study variables. No evidence could be found for significant differences in the investigated variables. Therefore, we did not control for organization in the different calculations.

To give an overview of frequencies of MSD in different body regions, descriptive statistics, including the mean and SDs, were calculated. They contain data about the existence of pain in any

body region and, more specifically, about lumbar and cervical pain separately. In addition, we evaluated data from the self-reported pain drawing so that the frequencies of lumbar and cervical pain could be compared with the frequencies of other pain regions.

To answer the question of how work–family conflict, interruptions, and influence at work predicted lumbar and cervical pain, a multiple regression analysis was conducted for each of these two outcome variables. The advantage of this method was to control the influence of confounding variables [42]. Demographical control variables were age, sex, and whether the participants smoked. Quantitative work demands (COPSOQ, 4 items), degrees of freedom at work (COPSOQ, 4 items), and shift work ("Do you work shifts? Yes/No") were also included as control variables to show that work–family conflict, interruptions, and influence at work are valuable predictors over and above the well-established ones [3]. Because of the directional hypotheses, the 5% α level was one-tailed for all regression analyses [42].

3. Results

3.1. Frequencies of MSD

One aim of the study was to investigate the prevalence of MSD in OR nurses in Switzerland. The frequency distribution of the current sample shows that 66.1% of the OR nurses reported suffering from MSD. There were 52.7% of the investigated OR nurses that reported pain in the lumbar region, 38.4% in the cervical region, 20.5% in the region of the mid spine region, 20.5% in knees and legs, 9.8% mentioned pain in the hands and feet, and only 5.4% in the head area (see Table 1). Many OR nurses named more than one pain region, causing the percentage values to exceed 66.1%.

Detailed analysis of the NASS unfolded means onto a six-point scale of mean = 1.56 (SD = 0.53) for cervical and mean = 1.59 (SD = 0.61) for lumbar pain. The sample size, means, SDs of all the examined variables can be seen in Table 2.

Table 3 displays the intercorrelations of the study variables. Except for the correlation between lumbar and cervical pain ($r = 0.735$), there are no correlation coefficients between predictor variables exceeding $r = 0.307$. Therefore, the assumption of multicollinearity can be disregarded thus far.

3.2. Prediction of MSD

Multiple linear regression analyses to predict lumbar pain by physical and psychosocial variables (controlled for each other) revealed that significant positive regression coefficients could be found for smokers ($\beta = 0.161$, $p = 0.032$), people with work–family conflicts ($\beta = 0.228$, $p = 0.015$), and for the extent of interruptions at work ($\beta = 0.170$, $p = 0.040$). In other words, OR nurses who smoked, who indicated a higher extent of work–family conflict or interruptions at work reported suffering more from pain in the lumbar region. Moreover, a significant negative coefficient could be found for the influence at work ($\beta = -0.167$, $p = 0.036$), meaning that OR nurses with little influence at work reported more lumbar pain. Contrarily, age ($\beta = 0.058$, $p = 0.266$) and sex ($\beta = 0.112$, $p = 0.117$) did not predict lumbar pain. Therefore, it was not the case that the older the OR nurse was, the greater his or her reported lumbar pain was. Likewise, female OR nurses were not more intensively affected by lumbar pain than were male OR nurses. Quantitative work demands ($\beta = 0.020$, $p = 0.422$), degrees of freedom at work ($\beta = -0.048$, $p = 0.307$), and shift work ($\beta = -0.012$, $p = 0.551$) were not significant predictors of reported lumbar pain as well (see Table 4).

Regarding the prediction of cervical pain by physical and psychosocial variables, a significant positive β-coefficient could be found for work–family conflict ($\beta = 0.170$, $p = 0.047$) and a significant association for the extent of interruptions at work ($\beta = 0.156$, $p = 0.049$). Here too, OR nurses who indicated having a high work–family conflict or a lot of interruptions at work reported more cervical pain. Sex turned out to significantly predict cervical pain too, in that female OR nurses suffered more intensely from cervical back pain ($\beta = 0.196$, $p = 0.017$). Age ($\beta = 0.088$, $p = 0.163$), being a smoker ($\beta = 0.126$, $p = 0.072$), and influence at work ($\beta = -0.099$, $p = 0.136$), in contrast, did not predict cervical pain. Thus, being older and a smoker did not lead to more reports of cervical back pain in OR nurses. Moreover, having a bigger influence at work did not seem to prevent cervical back pain. Quantitative work demands were a significant predictor of cervical pain ($\beta = 0.219$, $p = 0.013$). Degrees of freedom at work ($\beta = -0.080$, $p = 0.191$), and shift work ($\beta = -0.029$, $p = 0.626$) were not significant predictors of reported cervical pain (see Table 5).

Overall, Hypothesis 1, which states that the work–family conflict is significantly and positively associated with lumbar and cervical pain, was confirmed. Hypothesis 2, which states that interruptions at work are positively associated with lumbar and cervical pain, was also confirmed. Hypothesis 3, which states that

Table 2
Descriptive statistics of the investigated variables

	n	Mean	SD
Cervical pain	115	1.56	0.53
Lumbar pain	115	1.59	0.61
Age	116	39.94	11.90
Smoker	116	0.26	0.44
Sex	116	1.84	0.37
Quantitative work demands	116	59.02	13.40
Degrees of freedom at work	116	35.02	15.84
Shift work (0 = no, 1 = yes)	116	0.91	0.29
Work–family conflict	116	37.72	25.74
Interruptions	116	2.13	0.50
Influence at work	116	39.19	18.64

SD, standard deviation.

Table 1
Frequency of reported current symptoms in different body regions of the operating room (OR) nurses (multiple answers possible)

Frequency (%)	MSD	Body regions					
		Head area	Cervical region*	Mid spine region	Lumbar region†	Knees/legs	Hands/feet
	n = 115	*n* = 112	*n* = 112	*n* = 112	*n* = 112	*n* = 112	*n* = 112
Yes	66.1	5.4	38.4	20.5	52.7	20.5	9.8
No	33.9	94.6	61.6	79.5	47.3	79.5	90.2
Total (%)	100	100	100	100	100	100	100

* Includes: neck and shoulders.
† Includes: lower back, loins, hips, small of the back and pelvis.
MSD, musculoskeletal disorders.

Table 3
Pearson correlation matrix (one-tailed)

		1	2	3	4	5	6	7	8	9	10
1.	Cervical pain										
2.	Lumbar pain	0.735*									
3.	Age	0.092	0.056								
4.	Smoker†	0.118	0.166‡	−0.047							
5.	Sex§	0.130	0.050	−0.106	−0.005						
6.	Quantitative work demands	0.344*	0.184‡	0.105	−0.039	−0.061					
7.	Degrees of freedom at work	−0.183‡	−0.164‡	0.095	−0.118	−0.125	−0.063				
8.	Shift work (0 = no, 1 = yes)	0.091	0.064	0.028	−0.010	0.175‡	0.205‡	0.019			
9.	Work–family conflict	0.305*	0.307*	0.202‡	0.014	−0.203‡	0.390*	−0.180‡	0.138		
10.	Interruptions	0.250*	0.231*	−0.066	−0.071	−0.111	0.338*	−0.006	0.090	0.298*	
11.	Influence at work	−0.195‡	−0.236*	0.084	−0.047	−0.046	−0.144	0.267*	−0.040	−0.132	−0.091

* $p < 0.01$.
† 0 = no, 1 = yes.
‡ $p < 0.05$.
§ 1 = male, 2 = female.

influence on one's work is negatively associated with lumbar and cervical pain, was partially confirmed, but only for lumbar pain. Furthermore, being a smoker predicted lumbar pain, whereas sex predicted cervical pain. In the multiple linear regressions, 19.6% of variation in lumbar back pain and 24.6% of variation in cervical pain was explained by the investigated predictors. The effect sizes of joint predictions from work interruptions, work–family conflict, and influence at work in predicting MSD were $f^2 = 0.24$ in lumbar back pain and $f^2 = 0.26$ in cervical back pain, and were moderate following Cohen's suggestion (1988).

4. Discussion

One purpose of this study was to examine the frequency of MSD among OR nurses. A vast majority of the study sample (66.1%) suffered from musculoskeletal complaints and many of them named more than one pain region. Lumbar pain and cervical pain were the most prevalent musculoskeletal complaints from OR nurses. In our study, 52.7% of the OR nurses reported lumbar pain and 38.4% reported cervical pain. This demonstrates that many OR nurses named multiple pain regions. These findings make it plausible that MSD is one of the most common causes of long-term absence from work (for more than 2 weeks) in Switzerland. In addition, nurses with MSD incur both high direct costs for treatment [44] and high economic costs due to absence from work and productivity loss caused by the MSD (International Association for the Study of Pain, no date). These figures are alarming and show that measures should be taken in the near future to improve the present situation.

A second purpose of the current study was to examine the predicting value of work–family conflict and interruptions at work as work stressors, as well as influence at work as a resource, on lumbar and cervical back pain. The two stressors, work–family conflict and interruptions at work, were positively related to lumbar and cervical pain. Therefore, stress seems to be a risk factor for developing musculoskeletal complaints. This result is in line with studies showing that physical and psychological stress at work enhances musculoskeletal pain [45,46]. Work–family conflict and interruptions at work for OR nurses will be discussed in the following section in more detail.

4.1. Work–family conflict

Work–family conflict was found to be a significant predictor for lumbar and cervical pain in OR nurses. There was a higher probability of suffering from musculoskeletal pain for OR nurses that experienced a lot of work–family conflict than there was for those with less work–family conflict. Hämmig et al [47] confirm this view

Table 4
Multiple regression analysis with psychosocial variables to predict lumbar pain (controlled for age, smoking, sex, quantitative work demands, degrees of freedom at work, and shift work)

	Unstandardized coefficients		Standardized coefficients	95% Confidence interval for B			
Predictors*	B	Standard error	Beta	Lower bound	Upper bound	T	p (one-tailed)
Age	0.003	0.005	0.058	−0.006	0.012	0.629	0.266
Smoker†	0.224	0.129	0.161	−0.014	0.474	1.735	0.032‡
Sex§	0.184	0.153	0.112	−0.120	0.488	1.200	0.117
Quantitative work demands	0.001	0.005	0.020	−0.008	0.010	0.198	0.422
Degrees of freedom at work	−0.002	0.004	−0.048	−0.009	0.005	−0.505	0.307
Shift work†	−0.025	0.191	−0.012	−0.403	0.354	0.129	0.551
Work–family conflict	0.005	0.002	0.228	0.001	0.010	2.200	0.015‡
Interruptions	0.207	0.117	0.170	−0.014	0.430	1.762	0.040‡
Influence at work	−0.005	0.003	−0.167	−0.012	0.000	−1.815	0.036‡

$R^2 = 0.196$.
* All variables are controlled for each other.
† 0 = no, 1 = yes.
‡ $p < 0.05$.
§ 1 = male, 2 = female.

Table 5
Multiple regression analysis with psychosocial variables to predict cervical pain (controlled for age, smoking and sex, quantitative work demands, degrees of freedom at work, and shift work)

	Unstandardized coefficients		Standardized coefficients	95% Confidence interval for B			
Predictors*	B	Standard error	Beta	Lower bound	Upper bound	T	p (one-tailed)
Age	0.004	0.004	0.088	−0.004	0.012	0.987	0.163
Smoker†	0.151	0.102	0.126	−0.052	0.354	1.472	0.072
Sex§	0.276	0.128	0.196	0.023	0.530	2.165	0.017‡
Quantitative work demands	0.009	0.004	0.219	0.001	0.016	2.261	0.013‡
Degrees of freedom at work	−0.003	0.003	−0.080	−0.009	0.003	−0.876	0.191
Shift work†	−0.052	0.159	−0.029	−0.367	0.263	−0.327	0.626
Work–family conflict	0.003	0.002	0.170	−0.001	0.008	1.691	0.047‡
Interruptions	0.163	0.098	0.156	−0.031	0.357	1.664	0.049‡
Influence at work	−0.003	0.003	−0.099	−0.008	0.002	−1.104	0.136

$R^2 = 0.246$.
* All variables are controlled for each other.
† 0 = no, 1 = yes.
‡ $p < 0.05$.
§ 1 = male, 2 = female.

by showing that employees with high work–family conflict were at the highest risk for pain in the back, shoulder, and neck [47]. The European Foundation for the Improvement of Living and Working Conditions supports this relationship, as they found that only 15.6% of the working population with low work–family conflict suffered from backache, but that this percentage rose by up to 53.8% in those workers who reported high work–family conflict [48].

Women tend to develop musculoskeletal complaints more rapidly than do men when work–family conflict is high [19,48]. Possible reasons for women's elevated sensitivity to work–family conflict could be that employed women have to accommodate work and household or child rearing responsibilities [48]. This is an important finding, as the labor force participation of women has risen from 40% in 1990 up to 62% in 2000, and this percentage has certainly risen since this date [49]. This supports the significance of work–family conflict in the present study because the vast majority of the participants were women.

Looking at the factors that predicted work–family conflict, the literature mentions regular overtime, having a variable work schedule, and being in a management position as the most significant predictors for work–family conflict for men. For women, the number of work h/wk, workload, having a variable work schedule and a high job status are strongly associated with work–family conflict. These findings make sense as the mentioned factors compete with private obligations and take a lot of energy resources, leading to role conflict between work and private life [50–53]. As the job description for OR nurses includes factors that also predict work–family conflict (e.g., regular overtime or variable work schedule), the fact that they report lumbar and cervical back pain is consistent between the study's findings and the predictive factors.

4.2. Interruptions at work

Interruptions at work were found to be significant predictors for lumbar and cervical pain. Although the majority of the participants reported that interruptions occurred rarely to sometimes, interruptions are significantly related to lumbar and cervical pain. Sources of interruptions in an operating theatre can include a beeper, a ringing telephone, external staff entering the OR, or missing/damaged equipment because the equipment was not checked prior to the surgical procedure [54]. Sevdalis et al [55] highlighted that external staff visiting the operating theatre distracted communication and interrupted work the most. Furthermore, case-irrelevant communication addressed to OR nurses led to significantly more distraction than did communication addressed to surgeons.

Interruptions are a source of stress, which in turn promotes musculoskeletal complaints [20,56]. Interruptions impede action regulation and require correct recall of the interrupted action. Recall of the interrupted work and reorganization of the task consequently requires extra time. To make up for the lost time, employees work faster, which can, in turn, evoke stress [57]. Furthermore, Flynn et al [58] found that interruptions can lead to errors. When someone wants to resume the interrupted task, he must recall his last executed action and the action that has to be done next [59]. If incorrectly recalled, the subsequent actions are wrong, resulting in errors [58]. In operating theatres, errors may have fatal consequences, even though they are small at first sight [60]. Working conditions should therefore be adapted so that interruptions, as mentioned above, can be avoided.

4.3. Influence at work

Besides work stressors, the current study also investigated the effect of influence at work on MSD. It was found that influence at one's work seemed to be a crucial resource, which protected OR nurses against lumbar back pain. However, the association for cervical back pain missed significance at a level of $p = 0.136$. As the direction of the relationship between influence at one's work and cervical pain was the same as with lumbar pain (that is, more influence was negatively related to pain), the authors assume that a bigger study sample might have been able to show a significant effect for cervical pain as well. The result is supported by the findings of Eatough et al [26], showing that high job control protected employees from developing low back pain by reducing the amount of strain. If employees were allowed to decide for themselves when to take a break and how to organize their work, they perceived much less strain, which in turn, reduced the risk for work-related musculoskeletal symptoms in the lower back. By contrast, Skov et al [31] found that decreasing the level of control tended to heighten the risk for neck pain. An interpretation of those findings is that a high level of job control enables employees to break down their work and take breaks when needed to provide relief to their muscles [26,31]. Research also shows that involving employees in the planning and implementation of changes at work

can prevent the development of work related back pain [61]. In nursing, a lack of control, especially due to unplanned work and due to difficulties in lowering workloads, was found to be a risk factor for lumbar back pain [28].

In a study investigating young nursing staff, Elfering et al [34] found that the epinephrine and norepinephrine levels were higher and the control over stressful events at work was lower in those nurses that reported more frequent episodes of back pain. It was suggested that low control at work might increase the activity of the sympathetic-adrenal medullar system, which seems to play an important role in the development of musculoskeletal pain. Because OR nurses perceive less job control than do registered nurses, their influence at work poses a real problem [7]. The authors see one reason being the fact that OR nurses are tied to the operation table during the entire operation (emergency cases excluded) and therefore have no chance to take a quick break to relax.

4.4. Further results

A further interesting finding of the current study was that smoking was related to lumbar pain but not to cervical pain, as it barely missed significance. However, the regression coefficient's direction for the relationship between smoking and cervical pain was the same as for smoking and lumbar pain (that is, that the more one smoked, the greater the perceived pain). Therefore, it can be assumed that smoking would have turned out to be a significant predictor of cervical pain as well, if the sample size had been bigger. The association is in line with studies reporting that smoking is a predictor for low back pain, even though the association was moderate [62–64]. Eriksen et al [65] found the connection between smoking and MSD in the degeneration of the tissue surrounding the vertebral spine due to a lack of oxygen feed caused by smoking. Smoke particles adhering to the blood vessels lead to vasoconstriction that, in turn, impedes the oxygen transport in the blood [66]. This results in malnutrition of the bones and spinal discs. This malnutrition weakens them and renders them more vulnerable to physical strain [65,67]. Although several researchers have demonstrated that spinal complaints are largely determined by heritability [68–71], spinal complaints are also influenced by environmental factors [72], again supporting the findings on the impact that smoking can have on back pain. More quantitative workload predicted higher cervical pain, a result that in OR personnel reflects also biomechanical load from prolonged standing.

Finally, it was found that sex predicted cervical pain. However, the result that women report more intense and disabling cervical pain than men cannot be justified or interpreted due to an uneven sample that was predominately female (84% women).

4.5. Practical implications for OR nurses

To reduce work–family conflict, which was found to be a significant predictor of back pain, Major et al [73] proposed the implementation of part-time work. As part-time work decreases the number of working hours, conflict between work and family would be reduced, which helps to prevent the development of musculoskeletal complaints [74,75]. The reduction of hours to part-time might help the investigated OR nurses in the current study too, because the majority worked 90% or full-time (42 contracted h/wk). Nevertheless, it has to be considered that working part-time is not a possibility for everyone because families with young children may need the income levels that only substantial working hours bring [76]. According to Morris [77], there are a variety of work-life interventions available and numerous ways to implement them. For OR nurses, adjustments in working time can be additionally achieved by a family-related leave for sickness or school functions, or by paid time off. Financial assistance is another way to reduce work–family conflict. Financial assistance can include credit unions, flexible spending accounts, or child care subsidies. Community-based programs, like on-site or near-site childcare and elderly care, can also help prevent work–family conflict. Reduced work–family conflict not only has a positive effect on the employee due to lower levels of perceived stress and physical complaints and improved job satisfaction and motivation, but also for the organization, as it increases the productivity by better employee-performance readiness, increased concentration and focus, better teamwork, as well as reduced absenteeism and turnover [77].

Because interruptions at work not only promote back pain, but also lead to errors with fatal consequences in an operating theatre, some ideas to reduce the amount of interruptions are as follows: beepers should be turned off during surgical procedures, nonurgent phone calls should not be forwarded to the operating theatre during surgical procedures, and extended planning and organization of surgical procedures should be made to ensure that all materials needed are at hand [54].

With regard to influence at one's work, which has been found to be a protecting factor at least/certainly in the development of lumbar back pain, OR nurses presented ideas at the LOPS Congress in Switzerland (Kongress der Vereinigung für leitendes OP-Personal, LOPS, Davos, November 2013) about enhancing one's influence at work. One idea was that OR nurses should be allowed to participate in the planning of operations, meaning that they could collaborate in deciding which colleagues to work with in the operating theatre. The realities of implementing these types of suggestions need to be investigated by the OR management. Further ideas on how to improve these psychosocial aspects could be subject of future research.

The literature also mentions other implementations to prevent MSD in general. Kant et al [78], for example, found that posture and movements of instrumentation nurses (nurses who work in the sterile field assisting the surgeon) were more harmful than those of circulating nurses (nurses who work in the nonsterile field, monitoring the surgical procedure and sterile field and setting up the OR for surgery). If instrumentation nurses could intermittently act as circulating nurses, their musculoskeletal complaints might be reduced. This proposition, however, needs to be checked for feasibility of implementation by the OR management. Physical exercise and stretching are additional ideas to prevent musculoskeletal complaints [9,12]. A physiotherapist could be recruited to devise an exercise program specifically tailored to the needs of OR nurses [79]. For OR nurses to do the exercise program regularly, a room in the hospital could be provided, equipped with simple training instruments, such as balls and yoga mats. This enables them to do exercise during breaks or before/after work. Another approach lies in stochastic resonance whole body vibration that has been proven to reduce musculoskeletal complaints in different non-nursing occupations [61,80,81]. Elfering et al [21] examined whether or not a positive effect of such training can be found with OR nurses as well.

4.6. Limitations

A drawback of the study certainly was the fact that our sample size might have been too small to find small effects. The association between influence at work and cervical back pain, as well as between smoking and cervical back pain, narrowly missed significance, whereas the relationship with lumbar back pain reached significance. For both independent variables, the direction of the relationship was the same as for lumbar back pain. Therefore, it can

be assumed that a bigger sample size would have been able to support an existing predicting value of smoking and influence at work on cervical back pain. The minimal sample required for a multiple linear regression analysis with a fixed model, six control variables, and three predictor variables, conducted to explain incremental variation over and above the control variables with medium effect size of $f^2 = 0.15$, a given one-tailed $\alpha = 0.05$, and 80% power, is $N = 78$ (d.f. = 68). Thus, the statistical power in this study was sufficient for medium effect sizes, but it is too small to detect small effects. The minimal sample size required to detect small effects ($f^2 = 0.02$) would have been much larger ($N = 550$, d.f. = 540). Another disadvantage is that the conducted study has a cross-sectional design. To be more certain about the direction of those associations, a longitudinal study design with a control group should be conducted. Moreover, we also have to question a reporting and a selection bias. It cannot be excluded that certain OR nurses selectively revealed or suppressed information in our questionnaire. Thus, the authors of the current study informed the participants in writing, as well as verbally, that their indications will be treated anonymously and that neither their supervisors nor coworkers will have insight in personal specifications. Additionally, several OR nurses as well as supervisors gave us the verbal feedback that they are glad that finally someone deals with the subject of MSD in their occupation. Those feedbacks would therefore rather speak against a reporting bias, because the participants seemed to be rather willing to report their actual health and working conditions. Concerning a potential selection bias, it was not possible to randomly choose OR nurses to participate in the current study. As it is very difficult to recruit health professionals due to high work demands and time pressure (which also explains a rather low participation rate of 42.6%), we had to include those OR nurses who were willing to participate in the study. To mitigate as possible a sample bias, we therefore tried to include a variety of hospitals, which differed in size and ownership.

Notwithstanding the above mentioned drawbacks, there are several strengths of this study too. According to the authors' knowledge, this study was the first to assess the occurrence of MSD in OR nurses in Switzerland. While research on OR nurses and MSD has been conducted in a few countries outside of Switzerland, corresponding studies conducted in Switzerland have not been found to date. Furthermore, the chosen hospitals were a mix between small and big, as well as private and public hospitals, allowing for the generalization of the findings to all OR nurses working in Switzerland. The findings of this study show the importance of MSD among OR nurses and give an insight into the crucial factors in terms of musculoskeletal complaints, as well as how to prevent MSD from developing.

5. Conclusion

This study revealed that musculoskeletal pain is widespread among Swiss OR nurses (66.1%), implying that there is a required need for action. The most affected body regions were the lumbar (52.7%) and cervical (38.4%) back. Musculoskeletal pain was found to be associated with certain work conditions. Work stressors, such as work–family conflict and interruptions, promote back pain, whereas having an influence at work can prevent MSD from developing or being aggravated. Therefore, stress-triggering factors, such as interruptions at work and high work–family conflict, should be reduced. Additionally, influence at work should be fostered by offering OR nurses the opportunity to collaborate in deciding in how to perform their job and in making their own decisions relevant to their job. Overall, these results emphasize the importance of good working conditions to promote OR nurses' health.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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